CONTRIBUTIONS FROM THE LABORATORY OF VERTEBRATE GENETICS

UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN

NUMBER 19 MAY, 1942

VARIATION IN THE DEER-MOUSE (*PEROMYSCUS MANICULATUS*) OF THE BAD LANDS AND BLACK HILLS OF SOUTH DAKOTA AND WYOMING

BY LEE R. DICE

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INTRODUCTION

THE nearly bare slopes of the strongly eroded Bad Lands of southwestern South Dakota form a striking ecologic contrast to the forested upper parts of the near-by Black Hills (Stebler, 1939). It has, accordingly, seemed desirable to compare critically the characters of the deer-mice (*Peromyscus maniculatus*) occupying these two areas. Deer-mice are rare in the Bad Lands, and only one stock was secured of sufficient size to produce noninbred laboratory offspring in numbers adequate for statistical treatment. In the Black Hills, on the contrary, deer-mice are fairly numerous in most habitats and are common in heavy forest (Dice, 1939). From forested habitats of various types, five stocks are here described.

ACKNOWLEDGMENTS

The Cottonwood Basin, Hughes Pass, Otis, and Stockade Beaver Creek stocks were secured by A. M. Stebler while he was on an expedition supported in part by the Museum of Zoology, University of Michigan. The other stocks were trapped by me while I was engaged in field work sponsored by the Carnegie Institution of Washington. The statistical calculations were made by Donald M. Clarke.

METHODS OF STUDY

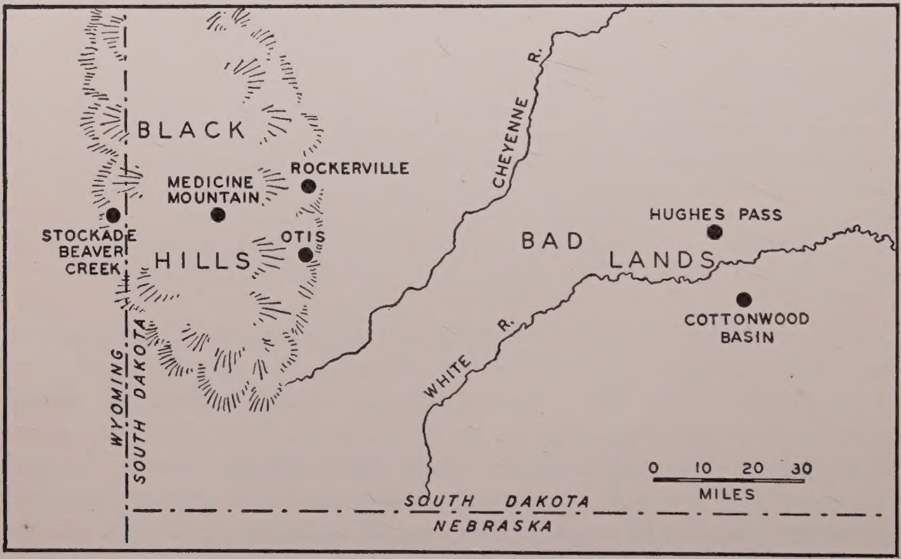
The methods of study employed are the same as those used in my previous investigations of variation in *Peromyscus* (Dice, 1932). All the animals described were born in the laboratory and were reared under nearly uniform conditions. When killed for measurement all were between the ages of thirty-six and seventy-eight weeks, and accordingly they are within the one-year age class.

Any difference between two means that is greater than about 2.7 times its standard error is here considered to be significant.

COLLECTING STATIONS

The stocks of deer-mice available for this study were secured at the following localities (Map 1):

Cottonwood Basin. In Cottonwood Basin, Washabaugh County, South Dakota, thirteen miles south of Kadoka.



MAP 1. Parts of southwestern South Dakota and southeastern Wyoming showing the collecting localities for the stocks described in this report.

Hughes Pass. On the "Wall" at Hughes Pass, Jackson County, South Dakota, seven miles west of Kadoka. Only nine laboratory-bred specimens of this stock are at hand. All these were derived from a single pair of field-caught mice. The means of the measurements of body and skeleton have, accordingly, not been included in the tables. The means of the tint photometer readings are given, but not their standard errors.

Otis. In western yellow pine forest on the lower slopes of the Black Hills, a short distance north of Otis and twelve miles east of Custer, in Custer County, South Dakota. Elevation, about 4300 feet.

Rockerville. In yellow pine forest on the lower slopes of the Black Hills, at Rockerville, about sixteen miles by road southwest of Rapid City, in Pennington County, South Dakota, Elevation, 4700 feet.

Medicine Mountain A. In heavy yellow pine forest with a few western white spruce on sheltered slopes; on the upper Black Hills, two miles north of Medicine Mountain and sixteen miles by road northwest of Custer, in Pennington County, South Dakota. Elevation, 6200–6300 feet.

Medicine Mountain B. In yellow pine forest one-half mile northwest of Station A and several hundred feet higher in elevation. Situation somewhat drier and forest more open than in Station A.

Stockade Beaver Creek. In yellow pine parkland near Stockade Beaver Creek, about twelve miles by road east of Newcastle, in Weston County, Wyoming. Elevation, about 4300 feet.

CHARACTER OF THE HABITATS

The Bad Lands of southwestern South Dakota consist essentially of a series of eroded valleys and basins that are continually encroaching on the surrounding plateau. Erosion is most vigorous at the margins of the basins, where often there is a steep "wall" several hundred feet high. Here the soil is mostly bare of vegetation. The soil on the steeper slopes of the Bad Lands is predominantly a pale grayish white, though there are occasional horizontal bands of rust or grayish green in pastel shades (Stebler, 1939: 391). The soils of most parts of the eroded basins are also relatively pale, though usually not so pale as on the rapidly eroding slopes. A thin growth of vegetation is present in many places. On the upland that has not yet been attacked by erosion, there is usually a good growth of plains vegetation with mostly an open sod. Here the surface soil is somewhat dark because of the accumulated humus.

No sample of the surface soil of either of the two Bad Lands stations is at hand. There is available, however, a surface soil sample from Cedar Pass that is said by the collector, A. M. Stebler, to be representative of the soil type of many parts of the Bad Lands. The tint photometer readings of this Cedar Pass sample average high, thereby indicating a pale-colored soil (Table I).

The lower parts of the Black Hills are covered mostly by yellow pine forest, in which the trees often grow in an open stand (Guthe, 1935). A small amount of humus has collected in the surface soil, giving it a moderately dark color. The tint photometer readings of the soil samples from the Otis, Rockerville, and Stockade Beaver Creek stations average considerably lower than those of the sample from the Bad Lands at Cedar Pass (Table I).

On the upper parts of the Black Hills near Medicine Mountain, the yellow pine forest grows usually in a closed stand. Some western white spruces grow on sheltered slopes and along the bottoms of some of the small gulches. There is a considerable accumulation of humus in the soil. No

TABLE I

COLOR OF SURFACE SOIL

Mean of ten tint photometer readings of each dry soil sample, in per cent

Station	Red	Green	Blue-violet
Cedar Pass	30.0	21.6	17.1
Otis	16.6	12.8	10.4
Rockerville	15.3	10.2	8.1
Medicine Mountain A	6.6	5.1	4.4
Stockade Beaver Creek	15.0	10.4	8.4

soil sample is at hand from the Medicine Mountain B station, but at the A station the soil is dark, as is shown by its relatively low tint photometer readings.

VARIATION IN PELAGE COLOR

The palest in pelage color of the stocks of deer-mice here described are the two from the Bad Lands. The tint photometer readings of the Hughes Pass stock average highest of all. The Cottonwood Basin stock averages significantly higher in readings than any of the stocks from outside the Bad Lands, except that for side red it does not significantly exceed either the Otis or Stockade Beaver Creek stocks (Table II).

TABLE II

PELAGE COLOR OF DEER-MICE FROM THE BAD LANDS AND BLACK HILLS

Mean tint photometer readings and standard errors, one-year age class, both sexes, in per cent

Stock	Dorsal stripe		
	Red	Green	Blue-violet
Cottonwood Basin	13.23 ± .30	9.51 ± .18	7.04 ± .13
Hughes Pass	15.89	11.44	8.11
Otis	11.60 ± .23	8.38 ± .16	6.13 ± .12
Rockerville	11.63 ± .30	8.44 ± .10	6.08 ± .23
Medicine Mountain A	9.42 ± .16	6.75 ± .12	5.03 ± .09
Medicine Mountain B	9.51 ± .19	6.80 ± .12	4.98 ± .08
Stockade Beaver Creek	11.06 ± .18	7.98 ± .18	5.57 ± .12
	Side stripe		
Cottonwood Basin	24.41 ± .43	17.46 ± .25	12.86 ± .21
Hughes Pass	30.78	22.22	15.00
Otis	23.18 ± .33	16.42 ± .24	11.84 ± .19
Rockerville	22.06 ± .34	15.89 ± .27	11.94 ± .23
Medicine Mountain A	19.41 ± .26	13.83 ± .21	9.84 ± .13
Medicine Mountain B	19.39 ± .36	13.61 ± .24	9.82 ± .19
Stockade Beaver Creek	22.94 ± .33	16.39 ± .27	11.45 ± .27

The darkest mice are those from the two Medicine Mountain stations, both of which are in the upper part of the Black Hills. The two Medicine Mountain stocks do not differ significantly from one another in any color comparison, but both have significantly lower tint photometer readings than any of the other stocks from the Black Hills or Bad Lands.

The stocks from Otis, Rockerville, and Stockade Beaver Creek are intermediate in shade of pelage color between the mice from the Bad Lands and those from the upper part of the Black Hills. These three stocks do not differ significantly from one another in any color comparison, except that the Otis mice have significantly higher average tint photometer readings than the Stockade Beaver Creek mice for the amount of blue-violet light reflected from the dorsal stripe.

The variability in pelage color is considerable among the Cottonwood Basin mice. This is shown by the high standard deviation of their tint photometer readings for reflected red (Table III). The great variability of color in the mice of this stock is obvious to the human eye. A few individual specimens are dark gray, very similar to typical *Peromyscus maniculatus bairdii;* a few are a much paler gray; a few are a rich buff, similar to some specimens of *nebrascensis;* but most Cottonwood Basin mice are intermediate in varying combinations of these several color types.

TABLE III

VARIABILITY OF PELAGE COLOR IN DEER-MICE FROM THE BAD LANDS AND BLACK HILLS

Standard deviations and standard errors of tint photometer readings, reflected red only, in per cent

Stock	Dorsal stripe	Side stripe
Cottonwood Basin	2.67 ± .21	3.80 ± .29
Otis	2.16 ± .16	3.15 ± .24
Rockerville	2.67 ± .21	3.07 ± .24
Medicine Mountain A	1.25 ± .11	2.10 ± .19
Medicine Mountain B	1.34 ± .14	2.55 ± .26
Stockade Beaver Creek	1.29 ± .13	2.35 ± .23

The Rockerville mice are to the eye considerably less variable in pelage color than are those from Cottonwood Basin. Their standard deviation for the tint photometer readings of red reflected from the side of the body is smaller than that for the Cottonwood Basin mice, but this is not true for the standard deviation of the readings of the dorsal stripe. The Otis mice also are less variable in pelage color than the Bad Lands mice, as is shown by their having smaller standard deviations than the Cottonwood Basin mice. The differences in standard deviations between these several stocks of mice are, however, not statistically significant.

The two stocks from Medicine Mountain and the one from Stockade Beaver Creek are the least variable in pelage color of the stocks here described. The standard deviations of the tint photometer readings for red of these three stocks do not differ significantly from one another. All three have significantly lower standard deviations for the readings for red than the stock from Cottonwood Basin. All three also have significantly lower standard deviations for the dorsal stripe readings for red than either the Rockerville or Otis stocks. In the readings for side red, however, only the Medicine Mountain A stock has a significantly lower standard deviation than the Rockerville and Otis stocks.

The considerable variability in pelage color of the Cottonwood Basin deer-mice is probably correlated with the diversity of soil color in the area in which they live. It has previously been pointed out that in the Bad Lands the soil of the recently exposed surface of the ''Wall'' is very pale. On the uneroded upland, however, the soil is fairly dark. Pale and dark soils occur in the Bad Lands in close juxtaposition.

On the forested Black Hills, on the contrary, the variation from place to place in soil color is relatively slight, and here there is only a small amount of variability in the color of the deer-mice. On these mountains nearly all the soil is fairly dark and most of the exposed rocks are also moderately dark.

No measure of the degree of variability of the soil color at any of the collecting stations is available, and it is therefore impossible to compare statistically the variability of soil color and of pelage color. There is, however, an evident correlation between the amount of variability in soil color in each region and the variability in pelage color of the deer-mouse inhabitants.

VARIATION IN DIMENSIONS

In the following size comparisons any stock whose mean for a particular measurement does not differ significantly from the largest mean of those here described is said to rank large. Conversely, any stock whose mean does not differ significantly from the smallest mean is said to rank small. All others are said to be intermediate in rank.

The Cottonwood Basin stock averages significantly shorter in length of ear than any other of the stocks here described (Table IV). This stock ranks small also in all the other measurements of body and skeleton except in length of tail, in which it ranks large. In length of body it does not differ significantly either from the largest or smallest stock.

The Otis mice average significantly shorter in ear length than the mice of any other stock except the one from Cottonwood Basin. In body length and in bullar width of skull the Otis mice also rank small. On the other hand, they rank large in length of hind foot, length of femur, and length of mandible. In the other measurements they are intermediate among the stocks.

The Rockerville mice rank among the smallest of the stocks in length of tail and in length of femur. In body length, length of foot, length of mandible, condylo-zygomatic distance, and bullar width of skull they rank large. In length of ear and condylo-premaxillary skull length they are intermediate.

The two Medicine Mountain stocks were trapped within about one-half

TABLE IV

MEASUREMENTS OF DEER-MICE FROM THE BAD LANDS AND BLACK HILLS

Means and standard errors of one-year age class, both sexes, in millimeters

Stock	No.	Mean age in weeks	No. of parents	Body length	Tail length	Foot length	Ear from notch
Cottonwood Basin	84	50	10	95.50 ± .50	63.53 ± .57	20.113 ± .094	16.221 ± .061
Otis	97	53	12	94.35 ± .42	63.44 ± .41	20.541 ± .058	16.914 ± .073
Rockerville	81	50	7	96.90 ± .54	61.54 ± .54	20.364 ± .079	17.774 ± .070
Medicine Mountain A	64	61	14	95.48 ± .49	63.21 ± .55	20.127 ± .085	17.573 ± .077
Medicine Mountain B	47	58	8	96.06 ± .73	65.66 ± .60	20.064 ± .084	17.809 ± .109
Stockade Beaver Creek	52	53	5	96.31 ± .61	61.64 ± .46	20.477 ± .105	18.413 ± .105

Stock	Femur	Mandible	Condyle-premaxilla	Condyle-zygoma	Bullar width
Cottonwood Basin	15.840 ± .078	16.078 ± .047	24.065 ± .068	17.433 ± .049	10.793 ± .025
Otis	16.162 ± .062	16.406 ± .038	24.584 ± .055	17.603 ± .040	10.827 ± .024
Rockerville	15.756 ± .069	16.363 ± .052	24.709 ± .073	17.836 ± .053	11.062 ± .027
Medicine Mountain A	16.016 ± .091	16.144 ± .044	24.333 ± .071	17.521 ± .056	10.891 ± .028
Medicine Mountain B	16.001 ± .095	16.055 ± .086	24.391 ± .105	17.449 ± .073	10.883 ± .035
Stockade Beaver Creek	16.288 ± .073	16.500 ± .047	25.023 ± .073	17.844 ± .053	11.012 ± .035

mile of each other in the same type of habitat. They are very similar in their dimensions, and only in tail length is there a statistically significant difference between them. In tail length the A and B stocks differ by 2.45 ± .81 mm., a difference 3.0 times its standard error.

The Medicine Mountain means do not differ significantly either from the largest or smallest means of the other stocks for body length or femur length. In tail length the B stock ranks large and the A stock small. In foot length, length of mandible, skull length, condylo-zygomatic distance, and bullar width of skull both rank small. In length of ear both stocks rank intermediate.

The Stockade Beaver Creek stock averages significantly larger than any other of these stocks in length of ear and condylo-premaxillary skull length. It ranks large also in body length, foot length, femur length, length of mandible, condylo-zygomatic distance, and bullar width of skull. Only in length of tail does the Stockade Beaver Creek stock rank small.

From the figures given it is evident that the smallest dimensions of body and skeleton among our stocks are exhibited by the mice from Cottonwood Basin. Only in length of tail do these mice rank large among the stocks here described. The largest dimensions are those of the Stockade Beaver Creek mice, and only in length of tail do these mice rank small. The other stocks occupy an intermediate position.

The Cottonwood Basin mice are from our most eastern locality, and Stockade Beaver Creek is the most western station from which mice were obtained for this study. It seems, then, that in general over this region there is a trend for the mice from the more eastern localities to be somewhat smaller in most dimensions than those from the west. The difference in size between our most distant stocks is not very great in any dimension, but neither is the geographical area covered by this study very large.

DISCUSSION

The deer-mice of the Bad Lands and Black Hills, so far as they are represented by the stocks here described, are larger in all dimensions than the mice of the subspecies *Peromyscus maniculatus bairdii* (compare Dice, 1937, Table I) from the prairies to the east.

The Cottonwood Basin stock, which is our only one with adequate measurements available from the South Dakota Bad Lands, is about the same size as the mice of the subspecies *nebrascensis* from the sand hills of western Nebraska (see Dice, 1941, Table IV). The means of the various measurements of these Cottonwood Basin mice can be closely matched by one or other of the sand hills stocks, particularly by those from the western parts of the sand hills.

The general tendency for deer-mice to increase in size toward the west over the Great Plains, shown by the stocks here described, is similar to that demonstrated for this species both north and south of this area (Dice, 1941:

15–16). So far as can be detected from this study the presence of the Black Hills does not in any significant way affect the trend for the deer-mouse to increase in size westward across the plains. The Black Hills stocks have been shown above to average, in general, intermediate in size between stocks from the Bad Lands to the east and those from Stockade Beaver Creek on the western side of the Black Hills.

Many specimens of the Cottonwood Basin and Hughes Pass stocks from the Bad Lands resemble the subspecies *nebrascensis* in pelage color. Furthermore, the tint photometer readings for all the specimens of these two stocks average close to those of stocks from the sand hills of Nebraska (Dice, 1941, Table II). In size also, as already pointed out, these Bad Lands stocks resemble *nebrascensis.* They must, accordingly, be assigned to that subspecies even though they are variable in color.

The stocks from the Black Hills are, on the contrary, much too dark to be assigned to *nebrascensis.* They are, furthermore, too large to be referred either to *bairdii* or to *nebrascensis,* and hence they are referred to the subspecies *osgoodi,* which is the form inhabiting the area to the west.

The pale pelage of the Cottonwood Basin and Hughes Pass stocks from the Bad Lands (Table II) is undoubtedly correlated with the pale soils of the area (Table I, Cedar Pass station). Likewise, the dark colors of the mice living near Medicine Mountain in the upper parts of the Black Hills are correlated with the dark soil of that forested area. At the Otis, Rockerville, and Stockade Beaver Creek stations on the lower slopes of the Black Hills, both the mice and the soils are intermediate in color. This trend toward correlation between the pelage color of mammals and the color of the surface soil of their habitat has previously been shown to exist in many other regions (Dice, 1940).

The exceptional degree of variability in pelage color exhibited by the Cottonwood Basin stock is evidently correlated, at least in part, with the considerable local variability in soil color in the Bad Lands of western South Dakota. A somewhat similar amount of local color variability has been described (Dice, 1941: 9–11) for some of the stocks of deer-mice that live near the border of the Nebraska sand hills.

The mice from the upper parts of the Black Hills are much darker than those from the lower slopes or from the surrounding area. They constitute, therefore, a local race. The mice of this dark local race are presumed to interbreed on all sides with the surrounding, less dark, populations living on the lower slopes of the Hills.

SUMMARY

The dimensions of the body and skeleton of the deer-mouse increase in moderate amount from the Bad Lands of southwestern South Dakota to the western base of the Black Hills. The presence of the Black Hills fails to interrupt this east-west size gradient.

The pelage of the deer-mouse averages pale on the Bad Lands, dark in the heavily forested upper part of the Black Hills, and intermediate on the lower slopes of the Hills. There is a tendency for the color of the mice to vary in accordance with the color of the surface soil of the habitat. The local population of the deer-mouse in Cottonwood Basin is highly variable in pelage color in a situation where there is much local variability in soil color.

The population of deer-mice living in the heavy forests of the upper Black Hills forms a local race distinguished by dark pelage.

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